

Claims

[c1] 1. An apparatus for purifying air used as a raw material in cryogenic air separation that separates nitrogen and oxygen mainly by distilling the air at low temperatures, comprising:
an adsorber comprising an adsorption cylinder that comprises a first adsorbing layer and a second adsorbing layer, wherein the first adsorbing layer comprises a first adsorbent capable of selectively adsorbing water in the air and the second adsorbing layer comprises a second adsorbent capable of selectively adsorbing nitrogen oxides and/or hydrocarbons in the air passing the first adsorbing layer, wherein
the second adsorbent comprises an X zeolite containing magnesium ion as an ion-exchangeable cation.

[c2] 2. The apparatus of claim 1, wherein the second adsorbent comprises a zeolite fabricated by exchanging a portion or all of sodium ions of a sodium X zeolite with magnesium.

[c3] 3. The apparatus of claim 2, wherein a magnesium-exchange ratio in total cations of the X zeolite is higher than 40%.

[c4] 4. The apparatus of claim 1, wherein the second adsorbent contains magnesium and calcium ions as ion-exchangeable cations.

[c5] 5. The apparatus of claim 4, wherein a magnesium-exchange ratio in total cations of the X zeolite is higher than 5%.

[c6] 6. The apparatus of claim 1, wherein the second adsorbent comprises an A zeolite containing calcium and magnesium ions as ion-exchangeable cations in replacement of the X zeolite containing magnesium.

[c7] 7. The apparatus of claim 6, wherein a magnesium-exchange ratio in total cations of the A zeolite is higher than 5%.

[c8] 8. The apparatus of claim 1, wherein a third adsorbing layer is disposed between the first adsorbing layer and the second adsorbing layer, wherein the third adsorbing layer comprises an adsorbent capable of selectively adsorbing

CO_2 in the air.

[c9] 9. A method for purifying air used as a raw material in cryogenic air separation that separates nitrogen and oxygen mainly by distilling the air at low temperatures, comprising:
providing a purifying apparatus comprising an adsorber, the adsorber comprising an adsorption cylinder that comprises a first adsorbing layer and a second adsorbing layer, wherein the first adsorbing layer comprises a first adsorbent capable of selectively adsorbing water in the air and the second adsorbing layer comprises a second adsorbent capable of selectively adsorbing nitrogen oxides and/or hydrocarbons in the air passing the first adsorbing layer, wherein the second adsorbent comprises an X zeolite containing magnesium ion as an ion-exchangeable cation; and
using the first adsorbing layer to adsorb and remove water from the raw air and then using the second adsorbing layer to adsorb and remove the nitrogen oxides and/or the hydrocarbons from the raw air.

[c10] 10. The method of claim 9, wherein the second adsorbing layer also adsorbs and removes CO_2 from the raw air.

[c11] 11. The method of claim 9, wherein the purifying apparatus is used with a third adsorbing layer disposed between the first adsorbing layer and the second adsorbing layer, the third adsorbing layer comprising an adsorbent capable of selectively adsorbing CO_2 and the method further comprising using the third adsorbing layer to adsorb and remove CO_2 from the air passing the first adsorbing layer.